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ABSTRACT

In reviewing current literature on the importance of examples in the process of teaching learning, this report takes into particular consideration textbook approaches that emphasize the role of examples for comprehension and motivation. Utilizing a constructive theory of prose comprehension, it then attempts to specify the function of examples in the learning process. The reports show through data gathered from an empirical investigation that the facilitative effect of examples on the process of comprehension and on performance in comprehension tests applies only to learners with high prior knowledge. It reveals similar correlations regarding recall of general and illustrative propositions. The report concludes that while learners with high prior knowledge are able to use the additional information from examples to enhance their understanding and recall of basic information, the effect of examples on learners with low prior knowledge tends to be detrimental, since no adequate knowledge structures are available to cope with the additional strain of surplus information processing. (CRH)

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ON THE FUNCTION OF EXAMPLES IN INSTRUCTIONAL TEXTS

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SUMMARY

The report starts with a review of the current literature on the importance of examples in the processes of teaching and learning. Within this context, approaches that emphasize the role of examples for comprehension and motivation are taken into particular consideration. Based upon a constructive theory of prose comprehension, the attempt is then made to specify the function of examples in the learning process. Finally, an empirical investigation is described, dealing with the question of the comprehension-enhancement and the enrichment functions of examples in instructional texts. Findings indicate that the facilitative effect of examples on the process of comprehension and on performance in comprehension tests only applies to learners with high prior knowledge. With regard to recall of general and illustrative propositions the findings are similar. The results are interpreted from a cognitive psychological standpoint. While learners with high prior knowledge are able to use the additional information from examples to enhance their understanding and recall of the basic information, the effect of examples on learners with low prior knowledge tends to be detrimental, since no adequate knowledge structures are available to cope with the additional strain of surplus information processing.

1. EXAMPLES: THEIR IMPORTANCE FOR TEACHING AND LEARNING

1.1 EXAMPLES IN DIDACTICS

The importance of examples for learning is uncontested in the field of education. Two kinds of examples can be distinguished: instructional examples, which facilitate the transmission, growth, and anchoring of knowledge, that is, for which the instructional function is in the foreground; and educational examples, which serve to transmit values, attitudes, etc. In this paper, we shall be dealing with instructional examples only.

In the discussion of didactics, experts distinguish between a myriad of different kinds of instructional examples and attribute to them a corresponding variety of beneficial effects on learning (cf. Haase, 1930; Henkler, 1928; Henningsen, 1979; Wolf, 1970). "Initial examples" are supposed to provide an introduction into a general thematic area or to contribute to better understanding of the succeeding general problem statement. They also help enliven the learning process by evoking a feeling of personal relevance or unease in the learner by means of unusual or discrepant information. The reader is thus motivated to continue reading attentively and to intensify cognitive processing. "Illustrative examples" are meant to serve as aids for the interpretation of preceding general statements - that is, to make them more concrete or more vivid and thus more understandable. "Evidence examples" are meant to underpin the claim to general validity of certain higher order statements. "Control examples" make it possible to test the statements in question. "Counterexamples" are supposed to help clarify the limits of validity of general statements, and "application examples" are intended to anchor the material learned and to increase its transferability after knowledge acquisition has already taken place; at the same time, the generality of the learned material should become more obvious.

Examples should also help link already existing knowledge stores to concrete everyday experience. They should establish relations between more general and abstract concepts and more specific, concrete concepts from the perceptual world (directly available to the senses),

thus helping in the integration of knowledge structure. In this context, examples are something already known. They activate existing knowledge stores, while putting them in a new light. Hence, they emphasize new aspects within what is already known and thus bring about new links or new insights. The use of typical and pithy examples is considered a means of restricting the profusion of material in our school curricula - in correspondence with the principle of learning by example. According to Wagenschein (1956), teaching and learning by example also always implies a genetic process, or discovery in learning (cf. Bruner, 1961).

This brings us to another aspect of the use of examples in the instructional process: Examples can have the function of providing an information base. Using this foundation, the learner can arrive at new insights on his or her own by linking existing concepts with each other in new ways.

1.2 Examples in Instructional Psychology

Programmed instruction has also concerned itself with the function of examples in the teaching/learning process and with the use of examples in the framework of the so-called RULEG (rule-example) and EGRUL (example-rule) system (cf. Evans, Glaser, Homme, 19860; Markle, 1964; Taber, Glaser, Schaefer, 1971). After a rule has been presented, examples can contribute to the understanding of this rule and can enhance the learner's flexibility in its application (RULEG). Examples which are placed before a rule serve as an information base for better understanding of the subsequent presentation (EGRUL). An instructional program that uses examples to illustrate the steps leading to a general rule can, in addition, provide a feeling of discovery. This experience can be as effective as the experience of success encountered when derivations are made from a rule (Taber, Glaser, Schaefer, 1971). The motivational function of examples was particularly emphasized in the conception of programmed instruction.

In contrast to the behavioristically oriented idea of programmed instruction, cognitively oriented approaches allow a more detailed view of the function of examples in the learning process. In Ausubel's (1968) cognitive learning theory, examples are viewed as concepts on a lower hierarchical level. They facilitate the meaningful subsumption of informational details by improving the stability, clarity, and dissociability of concepts within the cognitive structure. The stability of higher order concepts can be improved by examples when, for instance, these define the concept in question in a different way and thus render it more context-independent or generalizable. Examples can contribute to the clarity of higher order concepts, as they enable the reader to understand otherwise unclear and abstract hierarchy-high concepts in a vivid and concrete form. The dissociability of concepts can be heightened when examples clarify similarities and differences between concepts on the level of factual information. The use of examples, according to Ausubel, contributes the greatest amount to understanding when concepts from higher hierarchical levels are presented first. The subsequent information in the examples is subsumed under the corresponding concepts and then takes effect indirectly, as described above.

Berlyne's (1960, 1963) curiosity theory implies that object-oriented learning motivation (epistemic curiosity) is furthered by examples through the improvement of information processing. Examples are considered by Berlyne to be one of the so-called "collative" variables, which can trigger surprise, uncertainty, confusion in the learner and thus evoke a cognitive conflict. This conflict produces epistemic curiosity. Epistemic curiosity expresses itself in cognitive exploratory behavior aimed at accessing knowledge for the resolution of the cognitive conflict. Relevant knowledge can be acquired, firstly, when the learner processes information while looking particularly for such knowledge as could contribute to a solution. Corresponding relevant knowledge can also be made available when concepts and schemata already present in the knowledge structure are actualized and analyzed. Hence, the effects of the cognitive conflicts induced by examples are more intensive processing and, as a consquence, better understanding and retention of the information to be conveyed.

Surprise, uncertainty, and confusion originate in this model due to informational details of the example which are not compatible with the learner's own expectations. An instructional method incorporating these effects is typical for methods of teaching by discovery. Here, the reader is provided at the outset with problem situations (examples, phenomena) and thus is motivated to show learning behavior directed toward independent solution of the problems (Bruner, 1961; Berlyne, 1963).

Examples, in Berlyne's concept, need not necessarily be the carriers of the conflict-evoking features. Cognitive conflict in the framework of presentational teaching methods is, as a rule, triggered by the way in which the general concepts are presented. Subsequent examples contribute to the clarification of the concepts and can help to furnish or to actualize that knowledge which contributes to conflict resolution, thus promoting successful epistemic curiosity behavior.

Extensive empirical investigations of the cognitive function of examples have been conducted in order to develop instructional strategies for transmitting concepts (Houtz, Moore, Davis, 1973; Klausmeier, Feldman, 1975; Merril, Tennyson, 1978; Stolurow, 1975; Tennyson, 1973; Tennyson, Steve, Boutwell, 1975). According to Tennyson & Park (1980, p. 55), important aspects in the development of such strategies deal with the relationship between the examples, the relationship between examples and nonexamples, the ordering of examples and instructional help, the development of a procedure for selecting an appropriate number of examples, and the relationship between coordinate concepts.

Instructional research, as discussed by Tennyson & Park (1980), views concepts as a <u>set</u> of specific objects, symbols, or events that have common characteristics (critical attributes) and can be referenced by a particular name or symbol. Concept learning is regarded as the identification of concept attributes capable of generalization; e.g., which can be applied to newly encountered examples and which can help distinguish examples from nonexamples (Carroll, 1964; Mechner, 1965).

In the deductive method of concept teaching, a definition of the concept containing all of its characteristic features should be provided before examples and nonexamples are presented (Carroll, 1964; Klausmeier, 1976). According to Tennyson and Park (1980), research results show that it is not sufficient to offer students a single definition of a concept. As Klausmeier (1976) stresses, students may only remember a chain of verbal associations when a definition is offered without examples and nonexamples. In order for students to learn a concept, and not a chain of associations, they must at least receive some examples and nonexamples to classify. Examples and nonexamples help the students to avoid mistakes caused by overgeneralization (identifying nonexamples as examples), undergeneralization (identifying examples as nonexamples), and misconception (identifying examples as nonexamples and nonexamples as examples), as described in the analysis of concept acquisition presented by Markle and Tiemann (1969). A set of examples and nonexamples which displays these characteristics is called a "rational set" (Markle & Tiemann, 1969).

Providing students with examples showing a wide range of variable concept features enables them to acquire generalization across rational sets; on the other hand centering the attention of the student on the difference between critical and variable features allows her/him to learn discrimination within rational sets.

According to Tennyson and Park (1980), the instructional materials for concept acquisition should be selected and arranged to accentuate the differences between equivalent (coordinate) concepts as well as the extent of each individual concept. Furthermore, the sequence of instruction should be constructed coherently, and the order of presentation of the organized contents should be determined on the basis of existing information about the learner's state of knowledge. Based on current findings, Tennyson and Park (1980, p. 65) derive the following four steps for teaching concepts.

1. The taxonomic structure of the concept should be determined. The three levels of concept structure - subordinate, coordinate, superordinate - should be analyzed and critical and variable attributes identified.

2. A definition of the concept should be produced with the help of the critical attributes, and, on the basis of the critical and variable attributes, a pool of examples should be prepared.
3. The examples should be arranged meaningfully in rational sets on the basis of their attributes.
4. The order of presentation of the rational sets should correspond to the levels of divergence and difficulty among the examples of a concept, and the order of presentation of examples within the rational sets should be determined in accordance with existing information on the learner's state of knowledge.

Hayes-Roth (1978) has located another important aspect of concept learning based on examples. He points out that whenever we use a rule or try to learn a rule on the basis of instructive examples, we learn general rules in the form of combinations of attributes and relationships between objects. This learning process takes place even when it does not appear to be necessary. For instance,even when a general rule for a new concept is presented first, subsequent practice on specific examples will lead to the learning of generalized representations, derived directly from the characteristics and relationships observed in the specific examples. As both relevant and irrelevant features can be learned from every instructional example, undesired results of learning must be controlled. There are two possibilities for restricting the learning of irrelevant generalizations: (a) presenting examples with as few irrelevant characteristics as possible, and (b) insuring that the different examples for one general rule vary as widely as possible on irrelevant dimensions. As examples obviously influence behavior more than formal statements about general rules, learning can best be supported by identifying the characteristics and relationships of the knowledge in question first and then ensuring that each example incorporates all important features.

1.3 Examples in Research on Learning from Texts

Theoretical approaches and empirical findings about the facilitating effect examples have on learning were taken up in research on learning from texts. They are discussed, for instance, in the so-called comprehensibility concepts. In Groeben's concept (1972, 1982), examples play the same role as described above for Ausubel (1963, 1968) and Berlyne (1960). To enhance comprehension, Groeben (1978) suggests increasing the redundancy of a text by using additional examplary information.

In another concept comprehensibility, Schultz von Thun and Tausch (1974) consider examples to be suitable aids for improving text clarity. This effect is attained in the authors' opinion, when examples clarify an abstract and unclear general concept for the reader in a concrete and vivid way. Examples that exhibit a high measure of concreteness and vividness and that are "true to life" - that is, related to the personal experience of the reader - are located on the positive side of the clarity dimensions "simplicity" and "additional stimulation" (see, for instance, Langer et al., 1974, p. 49, pp. 122 ff.). A more indirect effect is attributed to examples with respect to the text dimensions "structure/organization" and "brevity/conciseness": examples have a favorable effect on structure and organization when they contribute to the transparency of the text by discriminating between important and unimportant contents. The redundancy of the text is increased by examples, while its brevity and conciseness are reduced.

A differential analysis of the comprehension and retention of texts sequenced according to the principle-example structure was undertaken by Marton and Wenestam (1978). Texts formed according to the principle-example structure have a hierarchical organization; i.e., the statement of principle is assigned a superordinate position in relation to the example. Earlier studies by Wenestam (1978) and Marton and Säljö (1978) showed that when the principle-example structure was not understood, the hierarchical organization was structured sequentially in the understanding of the subjects. Principle (or general statement) and example were considered to be

two parts of a text with equal importance and without any particular link. In interview studies, Marton and Wenestam (1978, p. 641) found the following different niveaus in the comprehension of the principle-example structure:

- The principle, the example, and the relationship between them are understood.
- The principle and the example are understood (separately), but not well enough to understand the relationship between them.
- The principle is not understood, but is constructed on the basis of the fragments retained.
- The example itself is viewed as the main point of the text.

Viewed together, under consideration of the theoretical approaches and the empirical studies outlined above, the current stand of research can be characterized as follows: As far as the effects of examples on the actual process of understanding and learning are concerned, only relatively global assertions are found. Some approaches do indeed provide clues about the selection and arrangement of exarples and nonexamples in a course of instruction; however, they do not consider the effects that this instructional presentation has on comprehension and information processing. This disregard of the comprehension process is also reflected in the fact that differential analyses - in which the effects of examples on the learning process are analyzed in relation to the learning qualifications of the addressees - are still largely lacking. Detailed findings are particularly needed on learning from texts. Such findings could serve as an orientation base for the further investigation of how examples should be used in an instructional text. The goal in this context is to support the learning process in an optimal way under consideration of the respective learning qualifications, or to attain certain learning results in a specific group of addressees.

The following outline of a theory of text comprehension is intended to provide a theoretical framework in which the function of examples in learning from texts can be more exactly determined.

2. TEXT COMPREHENSION AS A CONSTRUCTIVE PROCESS

The comprehension of a text can be considered an active, constructive process in which characteristics of the reader (comprehension qualifications) and characteristics of the texts interact (Bransford, 1979). Bransford's theory is an attempt to explain text comprehension in the framework of just such a concept of reader-text interaction. The constructive approach particularly stresses the role of the reader and his or her comprehension prerequisites, qualifications. Understanding a text, according to Bransford, means constructing a semantic description, a coherent, meaningful content structure on the background of one's own previous knowledge and the perceived communicative context. The text, in this view, provides a basis in the process of content construction, but the resulting content structure can turn out differently according to the prior knowledge of the reader, his or her goals during information processing, and the perceived context of information transmission. The semantic description of the text constructed by the reader can thus deviate from that intended by the author. Prior knowledge takes influence on the comprehension of texts, according to Anderson (1977, 1978), in the form of so-called cognitive schemata. Cognitive schemata are understood here as subsystems of the cognitive organization of thematically related knowledge stores. They can be altered by experience and they regulate the reception and cognitive processing of the text information (see also Ballstaedt, Mandl, Schnotz, Tergan, 1981; Mandl, 1981).

In their text comprehension model, Kintsch and van Dijk (1978) distinguish between a series of subprocesses involved in the construction of a semantic structure. The semantic structure of a text, in this model, has two levels: the microstructure and the macrostructure. The basis of microstructural text processing is assumed to be the elementary units of meaning in the text. When reading a text, the reader strives to form a semantically coherent structure: the microstructure of the text (text base). This occurs in the process of a stepwise evaluation of the micropropositions as to their semantic significance. Previous knowledge, the reader's goal, and general cognitive abilities form the basis for this process.

Kintsch and van Dijk further assume that a process of macrostructure formation takes place simultaneously. Macrostructures are understood as summarizing, condensed mental representations of the text content. Information reduction takes place in accordance with "macrorules" such as dropping, generalizing and (re-)constructing propositions, and is under the control of schemata (for instance, knowledge about which information in a certain kind of text is important for the representation of the text content). Macrostructures display differing degrees of generality according to their level of abstraction. In the authors' view, a text is comprehended when the reader succeeds in building a coherent conceptual structure on the micro and macro levels. The more effortless the construction process, the less problematic the comprehension process and the greater the comprehensibility (Kintsch and Vipond, 1979; Miller and Kintsch, 1980). So-called elaborations - mental processes induced by features of the text or initiated by the reader him- or herself and consisting of link formation between text information, personal experience, and individual knowledge - can lead to deeper text processing. As a result of the more thorough networking, the retention of text contents is improved (Reder, 1978, 1980; Mandl, Ballstaedt, 1981).

According to the line of reasoning within the text and depending on the reader's attitudes and values concerning text content and author, text contents can be more or less convincing. Thus, they can result in different cognitive processes and learning results (see also Abelson, 1979; Frey, 1979; Toulmin, 1958).

Theories of motivation suggest that the comprehension process is influenced by the motivational incentive (potential) of the text itself (Berlyne, 1969, 1963) as well as by the reader's expectations and evaluations with regard to the results of text processing (Heckhausen, Rheinberg, 1980; Krieger, 1981) and by his or her interests (Schiefele, 1974; Schiefele, Hausser, Schneider, 1979). According to Berlyne's curiosity theory (1969, 1963) as described above, text characteristics such as examples can elicit surprise, uncertainty, and confusion in the reader and thus evoke a cognitive conflict with existing expectations. This conflict results in epistemic curiosity, which in turn leads to heightened text-specific attention

aimed at conflict resolution. The consequence of conflict resolution processes is better comprehension and retention of the text contents.

Berlyne's theory of stimulus-induced motivation has been expanded by Krieger (1982) to a general value-expectation theory of the desire for knowledge. In this theory, characteristics of the learner (processing capacity, value orientations, goals) interact with those of the learning situation. According to Krieger's theoretical assumptions, the conditions for optimal cognitive text processing are given when the learner experiences an intermediate level of "relevant subjective uncertainty" about mastering the learning task. The aspect of relevance corresponds to the expected benefits of an action in the motivation model of Heckhausen and Rheinberg (1980). According to these authors, personal action is only undertaken "when the result of this action has consequences which are rated as positive, and when the necessary result appears attainable by means of personal action" (p. 16). It is assumed that learning actions are always purposeful, and that they can be both intrinsically and extrinsically motivated and directed by individual interests. Text processing, in this model, is motivated when the action-result expectations and result-consequence expectations are positive.

3. EXAMPLES IN TEXT COMPREHENSION

3.1 TEXT CONTENT STRUCTURE

Examples have a certain position within the content structure of the text. An example is always an example of something: namely, of more general statements, which are specified and sometimes made more concrete by this example. The example can - but need not - be an isolated case. It can also be a "more specific generality". The example can - but need not - be more concrete than the higher order generality. It can also be more specific without being more concrete at the same time. For instance, the concepts "lake" and "Lake Constance" differ from each other in their conceptual scope and in their degree of generality but not in their concreteness, that is in their "nearness" to directly perceivable reality. Fundamentally, and in agreement with

Kintsch & van Dijk (1978), example statements within the content structure of a text can be characterized as micropropositions with corresponding higher order general statements or macropropositions.

A large number of specific cases or corresponding micropropositions can usually be subsumed under the general statements or macropropositions; the macropropositions thus stand for a class of possible examples. The individual examples used in a text can be evaluated as to their typicality with respect to the set of "cases" belonging to a general class. The "family relations" between the individual instances in one such class of examples can be more or less close, as the number of common features shared by the instances vary. Within the cases subsumed under one category, then, there is a so-called family resemblance structure (Rosch, 1978) or, in other words, a structure of communality relations. The typicality of an example can be defined as the average degree of agreement between its features and those of other cases in the same category or as its position within such a family resemblance structure. If the examples are particularly typical, they are referred to as prototypes (cf. Jüngst, 1983).

Investigations of so-called schema abstractions have shown that humans are capable of using a number of examples to build up a cognitive schema representing that combination of features most typical for the respective series - even when no single example actually corresponds to this schema in all details. Although it is still unclear how such a schema formation process takes place, it can nevertheless be considered certain that humans have a basic sensitivity for feature correlations in their environment and, accordingly, that they note which features occur together frequently within one category. During the exposition of examples for a category, we acquire a set of features that then represents our category knowledge. We also learn which sets of features appear in particularly many instances of this category. Here lies the importance of using typical examples in the teaching/learning process; i.e., of finding examples that express the content of the higher order, more general statements in the most concise manner possible. The ability to transfer what is learner to other cases is related to the typicality

of the examples used during the teaching/learning process: The cognitive mastery of new instances in a category requires less effort when typical examples have been presented.

3.2 Concept Formation by Deduction and by Construction

If the question of the function of examples in learning from texts is restated, in terms of the theoretical background sketched in Part 2, then the following formulation results: To what extent do examples influence the construction of an integrated, mental representation of the text contents, including both semantic microstructures and macrostructures?

The comprehension of texts can be understood as the acquisition of complex concepts and thus as a form of concept learning. Aebli (1981) distinguishes between two basic forms of concept learning: the so-called concept formation by deduction, in which the learner must deduce a concept by him- or herself from examples and nonexamples; and the so-called concept formation by construction. The latter is understood as the transmission of a concept via definition or explication by a socializing agent. Here, the learner constructs the respective concept under supervision by putting existing knowledge elements together in a new way. Cognitive-psychological studies of concept learning usually only take the aspect of deductive concept formation into account (e.g., Bruner, Goodnow, Austin, 1956; Ach, 1921; Hull, 1929; Heidbreder, 1946-49). Aebli (1981), however, points out that an educated individual in the Western world has not invented most of the concepts he or she uses, but rather gets them from others: in daily association with other people, through systematic instruction, or from textbooks and written material.
As yet, detailed psychological theories and empirical findings on the function of examples in learning complex, meaningful material are lacking. This type of learning - in correspondence with the typical circumstances of human learning under direction - is organized as concept formation by construction. Such findings could serve as a foundation for the more effective design of teaching and learning processes.

The core of concept formation by construction, according to Aebli, is the establishment of relationships; i.e., the coordination of existing elements of knowledge. The initial elements in each such case of concept formation must be present in the knowledge stores of the learner. Prerequisites for concept formation by construction are the successful retrieval of the elements from the learner's memory and their correct linkage. According to Aebli, this formation process takes place, as a rule, through the intensive study of a single case - and not through the comparison of many different cases with the goal of eliminating nonessential object characteristics. Of course, it can be advisable to apply the concept to further cases in order to clear it of accidentals. But this "clearing" of a concept from the specific circumstances of its first introduction, which occurs in the process of its application, is not the formation of a new concept. Rather, it is the "working through" of an already existing concept with the goal of enhancing the learner's flexibility in using the concept in novel situations.

Concept formation by construction, according to Aebli, thus has nothing to do with the comparison of several instances or cases and the abstraction of their common features. Rather, it takes place on the content level of a concept and in reference to a single case. Accordingly, Aebli assigns instructional examples more of an illustrative function for more abstract topics than an actually supportive function for concept formation as such. He sees his view supported by the fact that the abstract terms are often named before the examples, whereby the reader can understand the abstract expositions without difficulty. Therefore, the concrete examples only serve to remind the concept learner of concrete experiences to which he or she can apply the concept being formed. They do not form the foundation of an abstraction process leading the learner to the higher order concept.

Thus, Aebli views the process of comprehension as pure concept formation by construction. In our opinion, however, this accentuation is too one-sided. In a certain sense, learning from texts, precisely because of the constructivity of text comprehension, also always involves a process which must be undertaken independently

by the reader. Hence it, also contains aspects of concept formation by deduction. From this vantage point, examples can help to make abstract expositions more understandable through concretization, in the sense of an inductive step in the transmission of knowledge; i.e., the respective micropropositions can also assume a helping function for the construction of higher order macropropositions.

3.3 Different Functions of Examples in Instructional Texts

With regard to the cognitive aspect of text comprehension in terms of the differentiation in micro- and macropropositions, it can be asked (in light of the individual cognitive abilities of the reader) whether the construction of higher order macropropositions would be successful even without examples - simply on the basis of suitable general and abstract statements - or whether the learner needs examples for the adequate interpretation of these statements. In other words, we can ask whether - in Aebli's terms - only the constructive aspect of concept formation plays a role in the formation of a macrostructure, or whether the deductive aspect of concept formation is also involved. Correspondingly, two major functions of examples in the cognitive processing of texts can be distinguished: the function of enhancing comprehension, and the function of enrichment.

3.3.1 The Comprehension-Enhancement Function

Examples can facilitate the understanding of higher order macropropositions: If the general exposition is too abstract to be understandable on its own - so that the learner has difficulty constructing the respective macroproposition - then suitable micropropositions can supply interpretational aids for clarifying how these general statements "are meant." Here, examples have the function of enhancing comprehension. In other words, the aspect of deductive concept formation plays a role for the learner.

Closely related to the function of enhancing comprehension is the verification function of examples. It involves convincing the learner of the truth of certain general statements. These general statements can be understandable enough with respect to their content, but their objective truth may still not be directly evident to the learner. In this case, examples can be introduced to serve a persuasion or verification function. If one includes insight into the truth of a statement as a part of its comprehension, then verification can be regarded as a variant of the comprehension-enhancement function of examples.

3.3.2 THE KNOWLEDGE ENRICHMENT FUNCTION

If general assertions are understandable for a learner even without examples, then the deductive aspect of concept formation does not come into play. The attainment of the respective macropropositions, in this case, merely follows the principle of concept formation by construction. The examples contained in the text no longer serve to enhance comprehension. However, they can themselves possess informational value and thus enrich the knowledge of the learner. It must be emphasized that not only the respective example-micropropositions as such are conveyed, but also their relationship to the higher order macropropositions. That is, the learner discovers that these micropropositions are actually examples of the macropropositions in question; the knowledge of the learner is enriched by the corresponding link. It is also possible that both the micro- and the macropropositions are already known to the learner, but that the relationship between the two elements of knowledge is not. In this case, knowledge enrichment consists specifically of these elements becoming linked.

The two major functions - enhancing comprehension and enriching knowledge - apply only to the cognitive side of text processing. However, it follows from the preceding discussion that examples in instructional texts can also have an effect on the motivation to learn.

3.3.3 THE MOTIVATIONAL FUNCTION

The use of examples can raise the incentive potential of an instructional text for the learner. Examples can contribute to cognitive conflicts - for instance, by making contradictory general theses more clear - and thus elicit epistemic curiosity in the learner. Examples from the learner's personal experience can also demonstrate that the higher order general statements are related to his or her reality (or are relevant). By creating personal involvement, examples can broaden already existing interests to include the general contents of the text. Furthermore, the learner's expectations with regard to the personal consequences of successful learning (action-result expectations) can be modified. Both these effects increase motivation to learn. It must also be acknowledged that the function of examples for enhancing comprehension, as discussed above, has motivational side effects as well: When difficulties in comprehension or "comprehension failures" are avoided during the processing stage, then this contributes to the maintenance of learning motivation.

In addition to the beneficial effects of examples on learning, however, inhibitory effects must also be suspected. For instance, the use of examples increases the amount of information to be processed. The reader must divide his or her attention between the general statements and the examples and cannot concentrate on the main points of the text alone. In addition, there is the problem of recognizing the main points within the more extensive amount of information and of weighting them accordingly (cf. Bartlett, 1978; Kintsch and Bates, 1977). This does not effect the comprehension-enhancing function described above, as adequate text comprehension is the basic prerequisite for successful learning. However, with respect to the enrichment function of examples, there is a certain opposition between facilitating and inhibiting effects on learning as reflected in the retention or the reproduction of text information. This opposition is described by Reder (1981 a,b) as a contradiction between two theoretical positions: the elaboration hypothesis and the focus hypothesis. The elaboration hypothesis assumes that our knowledge is represented in memory in the form of semantic networks. Enrichment produces a more differentiated network structure, so that more possi-

bilities are available for the retrieval of stored information and an improved basis is created for the referencing of the information to be retained. According to the elaboration hypothesis, then, better reproduction performance - with relation to the higher order macropropositions as well - can be expected when a text contains examples. On the other hand, in accordance with the focus hypothesis, poorer reproduction performance with respect to these macropropositions must be expected for a text with examples, as the learner must identify the macropropositions as the actual main points while he or she is processing the text - as already described above - and must spread his or her attention over a larger amount of information. Therefore, how these two aspects are related to each other - i.e., under what circumstances the one or the other effect predominates - is an important question.

4. INVESTIGATION OF THE COMPREHENSION-ENHANCEMENT AND KNOWLEDGE-ENRICHMENT FUNCTIONS OF EXAMPLES IN LEARNING FROM TEXTS

4.1 Focus of Investigation

The empirical investigation to be presented here studied the effectiveness of examples with respect to their comprehension-enhancing and enrichment functions. Attention was centered on the following questions:

(a) To what extent do examples promote the understanding of scientific instructional texts?
(b) To what extent do examples contribute to the enrichment of the knowledge structure?
(c) What influence do characteristics of the learner (prior knowledge, verbal intelligence) have on the effectiveness of examples?

4.2 METHOD

4.2.1 EXPERIMENTAL TEXTS

In order to test the questions stated above, two text versions were developed: one contained only the basic information (text without examples), and the other contained additional information in the form of examples (text with examples).

The basis used to develop our experimental texts was a passage from the radio course "Man and Environment" dealing with problems of ecology. The central topic in this passage was "ecological problems of lakes". One version was constructed by arranging the central concepts of the original version in an hierarchical sequence, beginning with general philosophical and sociopolitical aspects of the man-environment relationship and reaching as far as questions of special consequences of this relationship on fishery. This text version without examples was formed exclusively of general text information. The number of basic propositions was 153; the text was 3,701 words in length.

The text version with examples was composed by inserting examples into the body of the text after the corresponding general concepts. The examples, which were identical in content to those in the original radio text, contained detailed information for the clarification of general concepts on the one hand, and enriching information that went beyond the aspects addressed in the general concepts on the other. The total number of propositions was 243; 153 were the basic propositions and 90 were example propositions. In other words, 36 % of the text propositions were example propositions.

4.2.2 EXPERIMENTAL PROCEDURE

The investigation took place as a three-phase experiment. In the first phase, subjects' relevant prerequisites for comprehension (previous knowledge, verbal intelligence) were assessed. Previous knowledge was assessed by a word association test. Subjects were given 16 concepts from the text without examples, such as "ecological

balance", "ecosystem", "eutrophication" etc., and instructed to write down everything that occurred to them in association with these concepts. This knowledge production stage was limited to 1-1/2 hours. (In preliminary studies this amount of time had proven sufficient for completing the task without feeling pressured). Determination of individual content-specific previous knowledge was achieved by counting the concept-relevant propositions. Double namings were counted only once. The assessment of verbal intelligence took place after the determination of previous knowledge. Verbal subtests from Amthauer's intelligence structure test (IST) and Horn's achievement testing system (LPS) were used to build a total index.

In the second phase (two weeks later) the subjects (N = 60) were assigned randomly to one of the two experimental conditions (text with examples, text without examples). Their task was to read the experimental text within the allotted time of 1-1/2 hours in such a way that they could understand and retain as much as possible of its contents. While reading, the subjects were allowed to highlight the text, to take notes, or to reread earlier passages. During the subsequent written reproduction (immediate recall) of the text contents, the subjects had to reproduce as much of the text information as possible in a cohesive fashion without using the text itself for help. An adequate amount of time (1-1/2 hours) was available for reproduction.

In the third phase, another two weeks later, the subjects once again were asked to reproduce the text contents as completely as possible and in a coherent fashion (delayed recall). Following the reproduction test, the subjects were given a test with 150 "true/false" items to assess their comprehension of the basic information. Of these 150 items, 80 % had been judged by an independent rater to be comprehension items and 20 % to be recognition items. Again, the subjects had an ample amount of time to complete the test.

4.2.3 EVALUATION

The evaluation of the reproduction protocols was based on a list of propositions, compiled before the experiments took place and based on the experimental texts. Reproduction performance was measured in terms of the total number of correctly reproduced text propositions (basic and example propositions) on the one hand, and of the number of correctly reproduced basic propositions alone, on the other. The measure of individual comprehension performance was the number of correctly answered items in the comprehension text. These data were then subjected to three- and four-way ANOVAs. Criterial values were the reproduction performance and the point count in the comprehension test.

4.3 RESULTS

4.3.1 THE COMPREHENSION-ENHANCEMENT FUNCTION

If the examples used in the one text version allow better comprehension of the basic information,then it should be expected that the group which had read the text with examples would perform better in the multiple choice test (consisting primarily of items testing comprehension). In order to investigate the influence of the two text variants on comprehension performance under consideration of different learning prerequisites, a three-way ANOVA with the factors Text Version (with and without examples), Previous Knowledge (high vs. low), and Verbal Intelligence (high vs. low) was computed. The results are presentd in Table 1.

There are significant main effects for the influence of Previous Knowledge and Intelligence ($F = 7.675$, $p < .01$ and $F = 7.550$, $p < .01$, respectively). This is hardly surprising, as better prerequisites for learning naturally lead to better comprehension performance. However, there is no significant main effect for text versions. Thus, the examples used in the one text version did not, on the average, lead to better comprehension performance. Therefore, with respect to the examples used here and to the target group re-

presented by our subjects, we cannot speak of a general comprehension-enhancement function.

Tab. 1: Results of the three-way ANOVA on the influence of Text Version (with examples/without examples), Previous Knowledge (high/low), and Verbal Intelligence (high/low) on comprehension performance.

Sources of Variance	F	p
Text Version	.363	ns
Previous Knowledge	7.675	< .01
Verbal Intelligence	7.550	< .01
Interaction Text Version x Previous Knowledge	9.754	< .01
Interaction Text Version x Verbal Intelligence	.565	ns
Interaction Text Version x Previous Knowledge x Verbal Intelligence	3.319	ns

A somewhat more detailed picture is revealed by the analysis of interactions. There is a highly significant interaction between text version and previous knowledge ($F = 9.754$, $p < .01$). As a comparison of the different cell means given in Table 2 shows, this interaction can be attributed primarily to the fact that subjects with low previous knowledge performed significantly less well in terms of comprehension when they read the text with examples (Scheffé-test, $p < .01$), while persons with high previous knowledge showed at least a tendency toward better comprehension performance after reading the text with examples (the Scheffé-test barely missed the 5 % significance level).

Tab. 2: Mean comprehension performance, grouped according to the type of text processed (with examples/without examples) and the level of previous knowledge (high/low)

	Comprehension Performance				
	Text with Examples		Text without Examples		Scheffé-test
	$\bar{x}$	s	$\bar{x}$	s	p
Previous Knowledge (high)	119.1	12.2	112.7	9.6	ns
Previous Knowledge (low)	103.5	12.2	113.8	11.4	< .01

Thus, the question of the comprehension-enhancement function of examples must be answered more discriminately: Whereas learners with more previous knowledge can profit at least tendentially from examples, the latter have a negative effect on learners with less previous knowledge. The use of examples in instructional texts presents the learner with the additional tasks of emphasizing higher order general information within a more extensive body of information, or of distinguishing it from the example information, and of putting both into relation. Learners with little previous knowledge - due to the non-availability of suitable cognitive schemata - appear not to be sufficiently capable of this structuring performance. Apparently, they are not able to handle the larger informational volume caused by the additional examples; i.e., they are unable to form a sufficiently integrated semantic macrostructure as a memory representation, in which the central information is stressed and is distinguished from the more marginal information. Learners with more previous knowledge do not seem to have any difficulty with the structuring task. Their at least tendentially superior comprehension performance can perhaps be attributed to the fact that the content of the general, higher order statements is reasserted in another form in the examples. Thus, repeated encoding takes place during processing. Furthermore, these learners have a richer, more integrated information base at their disposal due to the additional examples, and thus they can answer the comprehension questions better. To summarize, examples can have either a more enhancing or a more inhibiting effect on the comprehension of text contents depending on the prerequisites of the learner.

4.3.2 THE ENRICHMENT FUNCTION

In order to determine the extent to which examples contributed to knowledge enrichment in our experiment, and as a consequence of the considerations laid out in Section 3, a comparative analysis was made of reproduction performance by learners who processed the text version with examples and learners who read the text version without examples. To allow a detailed analysis, the influence of previous knowledge and verbal intelligence was also taken into account. Two four-way

ANOVAs were run with the independent variables Text Version (with examples/without examples), Previous Knowledge (high/low), Verbal Intelligence (high/low), and Time of Reproduction (immediate/delayed). In one analyis the dependent variable was reproduction of the total information (basic information and examples); in the other, only the reproduction of the basic information. This allows a differentiated assessment of the effect of conditional factors on the two types of reproduction.

INFLUENCE ON THE REPRODUCTION OF TOTAL INFORMATION

Table 3 shows that all four factors yielded significant main effects: Text Version ($F = 5.116$; $p < .05$), Previous Knowledge ($F = 7.571$; $p < .01$), Verbal Intelligence ($F = 10.341$; $p < .01$), Time of Reproduction ($F = 251.155$; $p < .001$).

Tab. 3: Results of the four-way ANOVA on the influence of Text Version (with examples/without examples), Previous Knowledge (high/low), and Time of Reproduction (immediate/delayed) on reproduction performance (total information/basic information)

Source of Variance	Total Information		Basic Information	
	F	p	F	p
Text Version	5.116	< .05	25.771	< .001
Previous Knowledge	7.571	< .01	3.642	ns
Verbal Intelligence	10.341	< .01	6.808	< .025
Time of Reproduction	251.155	< .001	270.327	< .001
Interaction Text Version x Previous Knowledge	7.776	< .01	3.806	ns
Interaction Text Version x Verbal Intelligence	.418	ns	.128	ns
Interaction Text Version x Time of Reproduction	5.836	< .025	.872	ns
Interaction Previous Knowledge x Verbal Intelligence	.057	ns	.037	ns
Interaction Previous Knowledge x Time of Reproduction	2.199	ns	1.653	ns
Interaction Verbal Intelligence x Time of Reproduction	.003	ns	.752	ns
Interaction Text Version x Previous Knowledge x Verbal Intelligence	1.025	ns	1.570	ns
Interaction Text Version x Previous Knowledge x Time of Reproduction	.373	ns	.025	ns
Interaction Text Version x Verbal Intelligence x Time of Reproduction	3.141	ns	2.243	ns
Interaction Previous Knowledge x Verbal Intelligence x Time of Reproduction	.555	ns	.192	ns
Interaction Text Version x Previous Knowledge x Verbal Intelligence x Time of Reproduction	.141	ns	.002	ns

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These results indicate that learners who processed the text version with examples achieved better average reproduction scores than those who had received the text version without examples. Furthermore, higher mean reproduction scores are found for learners with high text-specific previous knowledge and high verbal intelligence; moreover, more is recalled in immediate reproduction than in delayed reproduction.

Significant interactions were found between Text Version and Reproduction ($F = 5.836$; $p < .025$) and between Text Version and Previous Knowledge ($F = 7.776$; $p < .01$) only. All other interactions were not significant.

An analysis of the interaction between text version and reproduction time shows that the influence of the text version is greater during immediate reproduction than during later reproduction. Learners who processed the text with examples recalled significantly more at the immediate reproduction stage (Scheffé test; $p < .01$). There was no significant difference in delayed reproduction (cf. Table 4).

Tab. 4: Mean reproduction performance for total information, grouped according to the type of text processed (with examples/without examples) and the time of reproduction (immediate/delayed)

	Total Information				
	Text with Examples		Text without Examples		Scheffé-test
	$\bar{x}$	s	$\bar{x}$	s	p
Time of Reproduction (immediate)	85.8	22.1	74.0	13.7	< .01
Time of Reproduction (later)	50.0	17.8	47.2	14.7	ns

The fact that learners with the more elaborate text recall more information at immediate reproduction seems rather trivial, as they have received more information. However, contrary to our expectations, after 14 days there were no longer any differences between the two experimental groups. The results indicate that the enrichment of a text by examples does not improve the long-term retention of the total information.

The significant interaction between Text Version and Previous Knowledge indicates that learners with high previous knowledge recall significantly more information after processing the text with examples than after processing the text version without examples (Scheffé test; $p < .01$). On the other hand, learners with low previous knowledge do not reproduce more information after processing the text version with examples (cf. Table 5).

Tab. 5: Mean reproduction performance for total information, grouped according to the type of text processed (with examples/without examples) and the level of previous knowledge (high/low)

	Total Information				
	Text with Examples		Text without Examples		Scheffé-test
	$\bar{x}$	s	$\bar{x}$	s	p
Previous Knowledge (high)	77.1	26.7	60.5	19.2	< .01
Previous Knowledge (low)	59.3	24.4	60.8	20.1	ns

Learners with more extensive text-specific knowledge seem to identify relationships between micro- and macropropositions better and to integrate these concepts better into the existing networks. Extensive previous knowledge helps to make things more clear, to close coherency gaps, to supply more plausible interpretations for ambiguous or unclear assertions. Learners with low previous knowledge, in contrast, appear to be less capable of constructing a differentiated network structure.

In contrast to text-specific previous knowledge, the level of verbal intelligence does not modify the influence of the text version on reproduction performance. The dichotomization in high and low verbal intelligence groups does not appear to differentiate the group studied here (law students) any further in this learning task.

INFLUENCE ON THE REPRODUCTION OF BASIC INFORMATION

Significant main effects were found for the factors Text Version ($F = 25.771$; $p < .001$), Time of Reproduction ($F = 270.327$; $p < .007$), and Verbal Intelligence ($F = 6.808$; $p < .025$). The variable Previous Knowledge barely missed reaching the 5% level of significance ($F = 3.906$; $p < .10$). None of the possible interactions was significant (see Table 3).

With respect to the reproduction of basic information, the examples in the text did not enhance performance. On the contrary: processing the example text led to significantly poorer reproduction of the basic information than processing the text without examples.

The results do not support the elaboration hypothesis, according to which enriching a text with examples leads to the formation of a more differentiated network structure, thus facilitating the recall and the accessing of the information to be remembered. Reproduction performance for the basic information was not better for the text with examples than for the text without examples. The results are in better agreement with the focus hypothesis. When reading a text with examples, the learner must divide his or her attention between the main ideas and the examples and cannot concentrate solely on the central ideas. Moreover, it is often difficult to identify the most important thoughts when additional informational details are supplied. This has the consequence of a stronger division or dispersion of available processing resources. In this sense, the relatively large portion of example propositions (fully 36 % of the text propositions) in the present investigation may have had an inhibiting effect on learning.

5. EDUCATIONAL CONCLUSIONS AND OUTLOOK

The present investigation has shown that, contrary to a widely held view in educational circles, examples in an instructional text do not have generally positive effects on the learning process. Rather, depending on the learning prerequisites of the addressees, they can have partially facilitating and partially inhibiting consequences for the learner. Recommendations for the use of examples in instructional texts should thus be of the differential type. Further investigations will have to analyze the functions of examples with respect to particular target groups and also scrutinize more closely the relationships between examples and the higher order general statements. Above all, investigations of the strategies with which learners process a text with examples would appear to be meaningful. Studies of this type could reveal how the learner interprets comprehension-relevant clues, establishes links with higher order statements and other examples, and structures the larger volume of information. Also of importance are studies in which not only the cognitive, but also the motivational effects of examples in instructional texts are analyzed. Detailed clues for the use of examples in the practical design of instructional texts can only be formulated on the background of a series of suitable investigations.

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